SDCS-03

DISTRIBUTION NETWORK GROUNDING CONSTRUCTION STANDARD (PART-II)

OVERHEAD NETWORK GROUNDING

Rev. 03

Revision History

#	Date	Revision No.	Major Revision Description
1	September, 2021	2	Added bonded tinned copper steel for MV
2	September, 2021	2	Figures Revise
3	October, 2023	3	Specify the location of LV (Neutral) Grounding

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1 GENERAL

1.1 Scope

This Grounding Standard describes the technical requirements for grounding the SEC overhead Distribution Network installations.

SEC Distribution System extends from the MV (33 kV, 13.8 kV) feeder outlets of HV/MV Substations down to SEC Customer interface including KWH-Meters and meter boxes.

1.2 Objective

Objectives of Grounding Standards are as follows:

a) To provide means to direct safely the un-desirable currents from the equipment to earth.

b) To assure that the persons are not exposed to the danger of critical electrical shocks in the vicinity of grounded facilities.

Objective (a) above is achieved by adequately selecting all ground fault current carrying components of Distribution System so that they are capable of safely carrying the ground fault currents for the expected duration of fault clearing times.

Objective (b) above is achieved by providing a ground system of adequately low resistance and arranged in such a way as to limit to safe levels the touch, step and transferred potentials in the events of ground faults.

1.3 Grounding System Elements

A Grounding System consists of ground conductors, ground rods, overhead line/equipment to be grounded and the ground accessories. Factors affecting the design of grounding system are as follows:

a) Magnitude and duration of ground fault current.

b) Portion of ground fault current which will pass to the ground.

c) Soil resistivity at fault location.

d) Degree of exposure of grounding system elements to mechanical damage and corrosion (this will influence the choice of materials).

1.4 Summary of Grounding Regulations

1.4.1 System Neutral Grounding

The SEC overhead distribution system is grounded as follows:

a) 33 kV and 13.8 kV Systems

These are 3-wire primary systems run on steel poles. MV neutral of power transformers is grounded solidly or thru low resistance at HV /MV substations.

Distribution transformers have DYn11 connections. The secondary side is solidly grounded and connected with MV grounding. A ground wire is continuously run under the phase wires and is grounded at the terminal pole and every fifth pole.

b) LV System

It is a 4-wire system and system neutral is multiply grounded at each pole and at consumer location.

1.4.2 Metal Work Grounding

For MV lines, the metal work of all overhead line distribution equipment is always grounded and bonded to continuous run ground wire. For LV lines, metal work shall be bonded to the neutral and grounded at each pole.

1.5 Grounding Materials and Methods

Below mentioned grounding methods and materials shall be used for all system configurations.

1.5.1 Grounding and Bonding Materials

ACSR conductor Quail (67.44 mm^2) shall be used as continuous running ground wire for MV lines. 16 mm (5/8 inch) diameter and 1x2400 mm long or 2x1200 mm copper weld ground rods with 70 mm^2 copper conductor or bonded tinned copper steel (for MV Grounding) and 35 mm^2 (for LV grounding) bare copper conductor shall be used for grounding applications.

In MV OHL grounding, bonded tinned copper steel shall be consider as a priority, if not available, then 70 mm^2 copper conductor can be used as alternative. Materials are described in respective figures of this Construction Standard.

1.5.2 Grounding Methods

Details of typical grounding arrangement for different types of distribution system installations are covered in respective clauses. Unless otherwise indicated on relevant figure, the grounding arrangements shown are for normal soil conditions where it is possible to drive ground rods into the soil without much difficulty. Details of a typical installation of one ground rod are shown in Figure 1. Where it is very difficult to drive the standard ground rod in soil, Copper wire buried horizontally to a depth of at least 500 mm is considered equivalent to placing ground rods (6m of wire length equivalent to one rod). This length is in addition to the connecting length of wire between ground rods and from pole to ground rods. The ground wire should be so installed that as far as possible, it forms a ground mat around the pole. Two ends of the wire must be connected to the pole grounding terminals. Before deciding to install ground wire in place of ground rods it should be investigated if normal (non-rocky) soil is available within a reasonable distance (up to 50 meters) from the installation. If available, the required number of ground rods should be installed in the normal ground and connected to the pole grounding terminals. The connecting ground wire from ground rods to the pole should form a ground mat around the pole. Copper ground wire alone (in place of ground rods) should be laid only if normal soil as described above is not available. For increasing the effectiveness of grounding arrangement, the adjacent grounding rods should not be located closer than 4 meters. In case of difficult situation less than four meters separation is acceptable. However, the respective SEC Construction Supervisor should satisfy himself that reduced separation is indeed unavoidable. In case 2400mm rods cannot be used, single 1200mm ground rod can be used with separation of 2m instead of 4m. To prevent overheating features of connections in the grounding systems, following shall be observed:

a) Unless specified in this standard, compression connectors shall be used.
b) Bolted connectors, when used, shall be properly tightened.
c) Penetrox or equivalent oxide inhibiting compound shall be used at all joints of dissimilar metals.
d) The compression connectors shall always be crimped using the correct tool and die.

2 BONDING OF LV NEUTRAL AND MV GROUNDS.

LV neutral ground and any grounds associated with MV equipment / system shall always be kept bonded.

3 GROUND RESISTANCE VALUES AND NUMBER OF GROUND RODS

Every pole with MV equipment installation shall be grounded with minimum of 4 ground rods. In high soil resistivity areas, such as rocky areas, loose soil, etc.; additional number of rods or equivalent length of ground wire shall be used to achieve the required ground resistance value.

Soil resistivity can also be improved by adding the appropriate Low Resistivity Materials (LRM) as described in SDCS-03 part 3.

All installations with Surge Arresters for protection of line equipment shall be grounded through minimum four ground rods.

Maximum recommended ground resistance for different installations is as follows:

System Ground	5 Ω
All Distribution Substation	5 Ω
Surge Arrestors	5 Ω
MV / LV Poles	20 Ω

4 OVERHEAD MV LINE INSTALLATIONS INCLUDING EQUIPMENT INSTALLATIONS

4.1 General

Details of grounding arrangements for poles for overhead lines and the overhead line equipment are given in respective figures as mentioned below.

4.2 Non plant poles with 33 kV & 13.8 kV, 3-Wire Circuits

The circuit elements generally consist of the steel poles, pole top line metal work consisting of cross arm and base metal work of insulators, which support conductors energized to line voltage. Such poles do not support any "Equipment" like cable riser, Transformer, Voltage Regulators etc.

Every fifth Pole of MV overhead line shall be grounded through single earth rod. In case of less than five poles in a line, Tee-off and the Terminal Pole shall be typical arrangement of pole grounding is given in Figure 1. No separate bonding is required for pole assembly metal work for steel poles.

4.3 Pole Mounted Transformers

Grounding arrangement for single and double pole mounted transformers is shown in Fig. 2 to Fig. 5. The PMT body shall be grounded through four (4) earth rods and tinned copper bonded steel or 70 mm^2 bare copper conductor. Neutral of transformer is grounded by bonding neutral bus bar inside LV cabinet with the body through a 70mm^2 copper link. MV & LV ground conductors shall be bonded to the continuous run ground wire. A ground mat shall be provided under the LV cabinet.

4.4 Pole Mounted Equipment with Control Cabinets or Switch operating handle

The equipment such as Line Auto Reclosers, Line Sectionalizes and Load Break Switches which have their operating handle or control cabinet near the ground level shall be grounded as per Fig. 6 and Fig. 7 and bonded with continuous ground wire. A ground mat shall be provided under the switch operating handle/ control cabinet to establish an equipotential zone.

4.5 Power Capacitors on MV lines

The grounding arrangement for power capacitor shall be as per Fig. 8. Grounding shall be through four (4) ground rods and tinned copper bonded steel or 70 mm^2 bare copper conductor.

4.6 Cable Riser

Grounding of cable riser shall be as per Figure 9. Grounding shall be through Four (4) ground rods and tinned copper bonded steel or 70 mm^2 bare copper conductor. Cable screens, armor and pole top metal work shall be bonded to ground wire.

4.7 Guys on Steel Poles

The pole top connection of guys, on all steel poles, already has a bond with ground through metal work and continuous running ground wire.

4.8 Surge Arrester Grounding

All overhead MV equipment shall be protected by Surge Arresters and shall be grounded through four (4) ground rods. Typical surge arrester connection
arrangement for PMT shall be as per Figures 4 and 5.

5 OVERHEAD MV AND LV COMPOSITE LINES

5.1 General

These networks are designed for use in the places with short of space and where the customers are located adjacent to MV overhead lines. The steel poles carry both MV conductor on post insulators and LV Quadruplex conductor.

5.2Bonding and Grounding of MV Network

All metal work is bonded together, and to the continuously running ground wire In case of less than five poles in a line, Tee-off and the Terminal Pole shall be grounded. For the lines with five or more poles, the grounding shall be carried out according to clause 4.0.

5.3 LV Neutral Grounding

a) The LV metalwork shall be bonded and grounded at each pole which is shared with MV circuits and at customers meter positions.
b) The neutral of each LV feeder shall be grounded through minimum of four (4) ground rods. These rods include the ground rods required to be installed at customer premises. Total number of minimum rods shall be as per following table:

No. of LV Poles	Location of Ground Rods
0	4 at meter installation (including customer provided ground rods)
1	4 at pole
2	3 first pole one at second pole
3	2 rods at first pole one rod at each next pole
4	One rod at each pole
5 or more	At least 4 rods per circuit

c) One rod shall be driven at the meter position for every 4 KWH meters served directly from a pole which carry both MV and LV circuit.
d) Connection between the LV neutral conductor and the grounding conductors shall be as shown in Overhead Construction Standards SDCS-01.
e) The grounding conductor shall be 35 mm².

6 OVERHEAD LV NETWORKS AND SERVICES (alone):

6.1 General:

Overhead LV Distribution System extends from the LV terminals of Pole Mounted Transformer to the terminals of KWH-Meter installations. It includes overhead LV Mains, Services and Meter boxes. Messenger of quadruplex shall be directly bonded and grounded at every pole. The grounding of LV poles shall be as per Fig. 1 (Except the grounding conductor shall be 35mm²). Total number of minimum rods shall be as per clause 5.3.

6.2 Grounding at the customer interface:

It shall be essential for the customer to provide grounding at his interface. The customer shall bring the grounding wire to the grounding terminals of the meter box. The ground wire of the customer shall be connected to the ground terminal inside the meter box. The ground terminal shall be short linked with the neutral. For grounding details see part-1 of grounding standard (typical arrangement of meter box as shown in Dwg.142 and Dwg.143 of Construction Standards SDCS- 01) Customer ground wire shall be installed through PVC conduit or protected by a suitable guard as described 20-SDMS-02 (Overhead Accessories).

7 GROUND RESISTANCE MEASUREMENTS

Below mentioned procedures shall be adopted for measurements of grounding resistance:

i. Measurement through fall of Potential method.
ii. Measurement through "Clamp on ground resistance measuring meter".

FIGURES:

FIG.01 -- STEEL POLE GROUNDING DETAILS

FIG.02–-SINGLE POLE MOUNTED TRANSFORMER GROUNDING ARRANGEMENT DETAILS

FIG.03 –-DOUBLE POLE MOUNTED TRANSFORMER GROUNDING DETAILS

FIG.03A --DOUBLE POLE MOUNTED TRANSFORMER GROUNDING DETAILS SECTION

FIG.04 –-POLE MOUNTED TRANSFORMER EARTHING DETAILED DRAWING

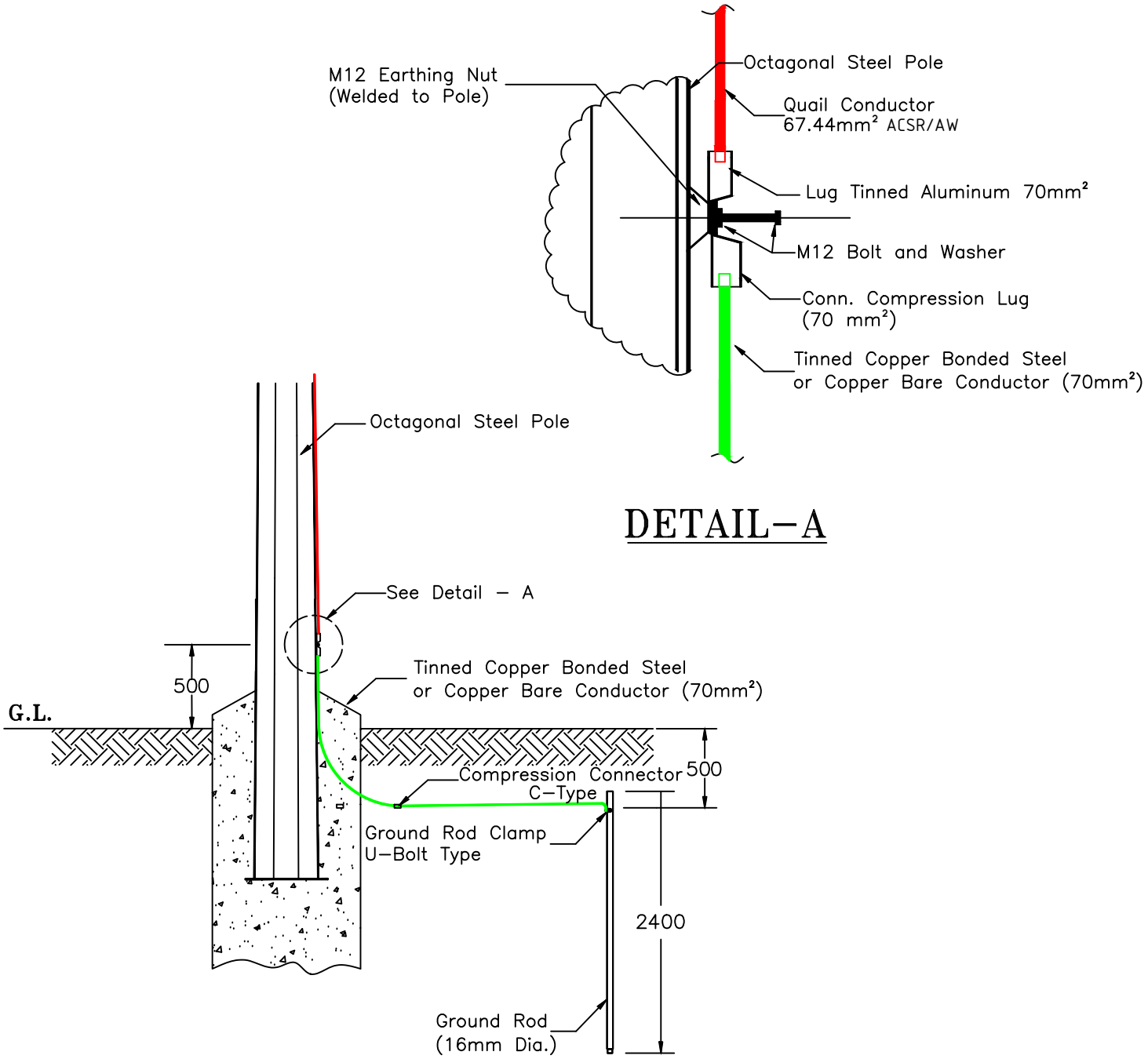
FIG.05 –-LIGHTING ARRESTER EARTHING DETAILED DRAWING

FIG.06 –-BONDING AND GROUNDING ARRANGEMENT FOR POLE MOUNTED EQUIPMENT WITH GROUND LEVEL CONTROL CABINET

FIG.07 –-BONDING AND GROUNDING ARRANGEMENT FOR POLE MOUNTED O/H LOAD BREAK SWITCH WITH GROUND LEVEL OPERATING HANDLE

FIG.08 –-GROUNDING ARRANGEMENT FOR CAPACITOR BANK (GROUNDED -Y)

FIG.09 –-BONDING AND GROUNDING ARRANGEMENT CABLES CONNECTED TO 3-WIRE MV-O/H LINES



DETAIL–A

ELEVATION

FIG.01 – STEEL POLE GROUNDING DETAILS

ALL DIMENSIONS ARE IN MILLIMETER

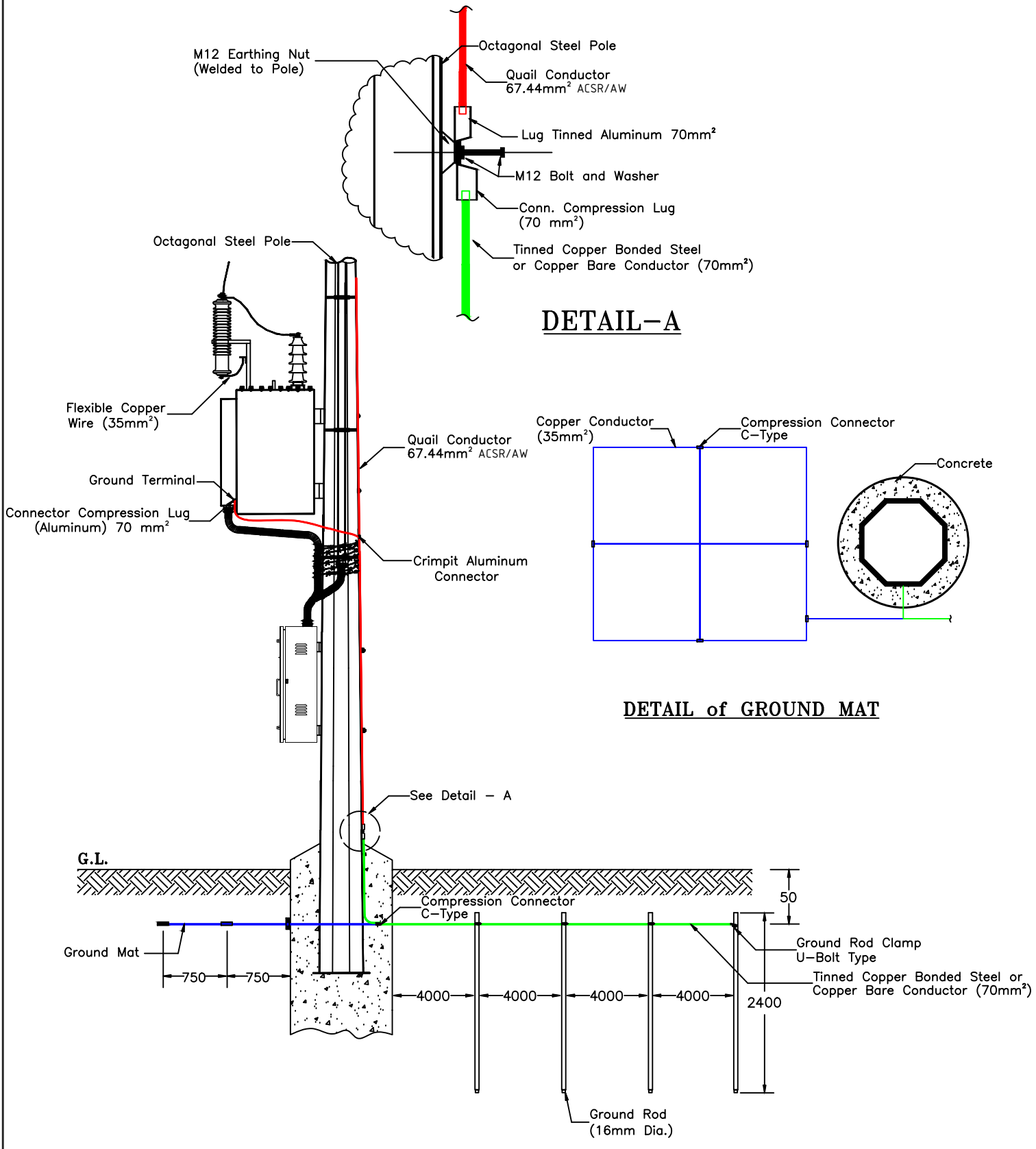
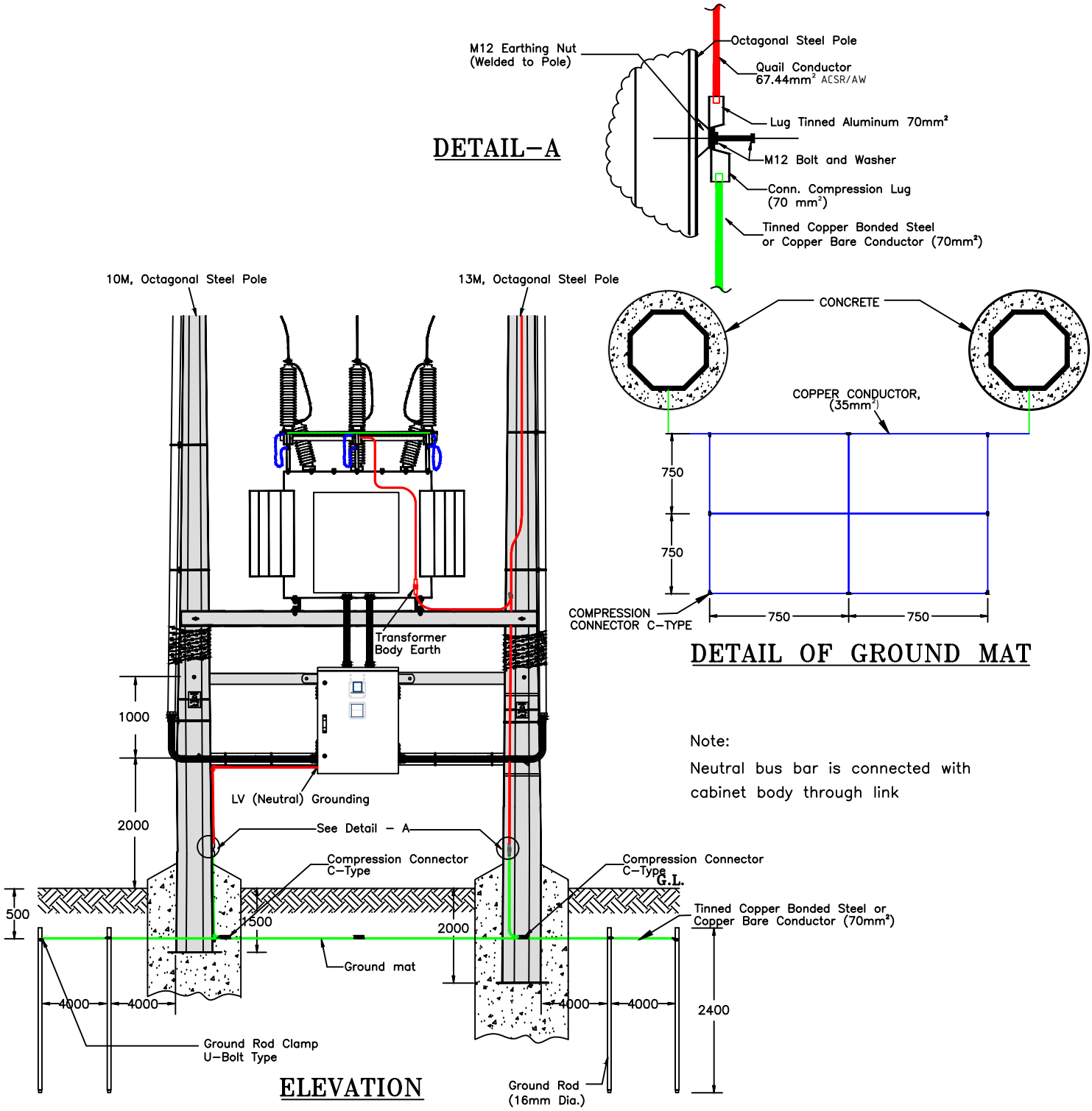


FIG.02 – SINGLE POLE MOUNTED TRANSFORMER GROUNDING ARRANGEMENT DETAILS

ALL DIMENSIONS ARE IN MILLIMETER



Note:
Neutral bus bar is connected with cabinet body through link

FIG.03 – DOUBLE POLE MOUNTED TRANSFORMER GROUNDING DETAILS

ALL DIMENSIONS ARE IN MILLIMETER

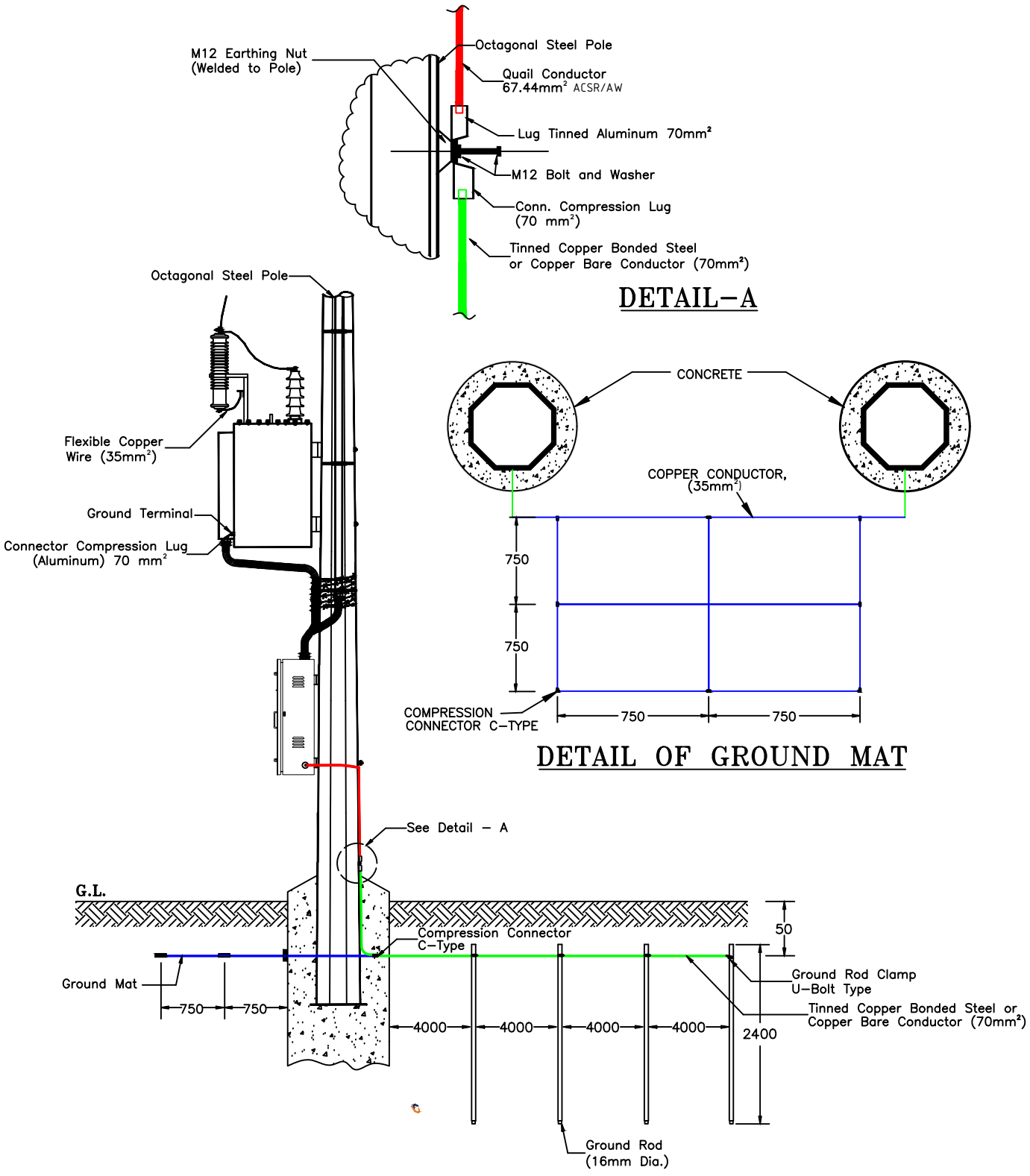


FIG.03A – DOUBLE POLE MOUNTED TRANSFORMER GROUNDING DETAILS SECTION

ALL DIMENSIONS ARE IN MILLIMETER

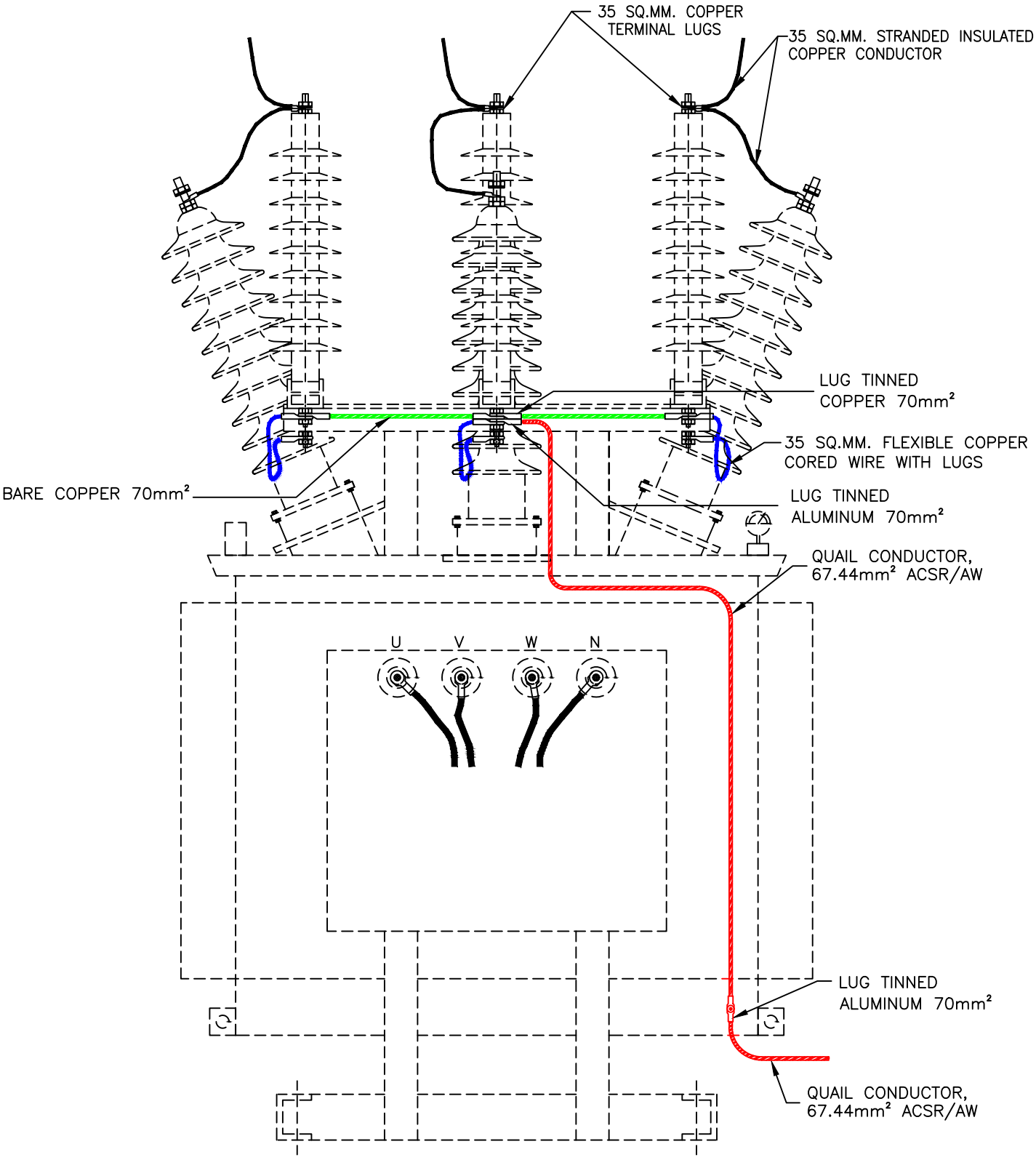
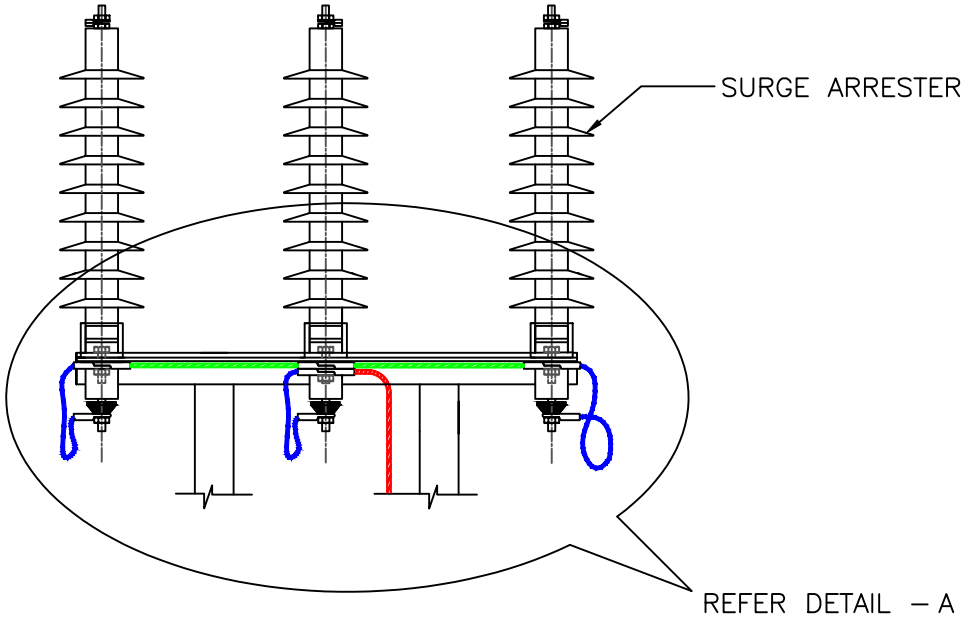
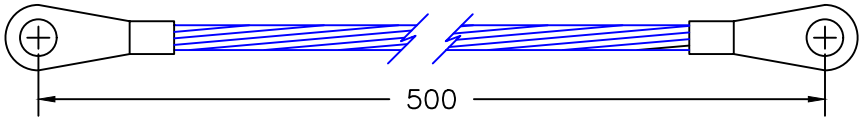


FIG.04 – POLE MOUNTED TRANSFORMER EARTHING DETAILED DRAWING

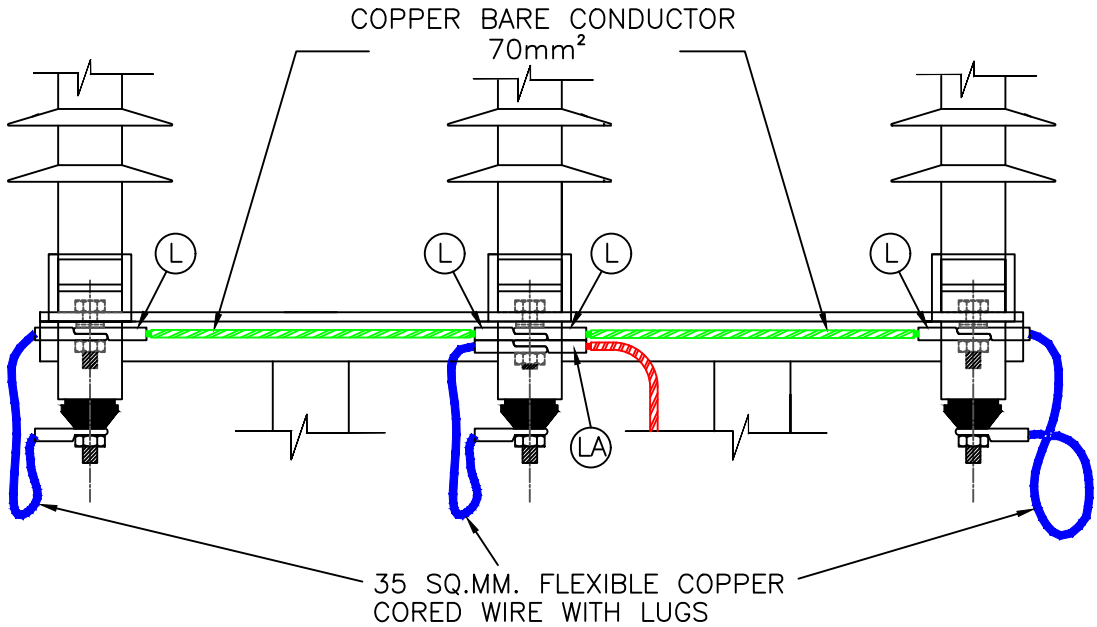
ALL DIMENSIONS ARE IN MILLIMETER



DETAIL – A



35 SQ.MM. FLEXIBLE COPPER CORED WIRE WITH LUGS

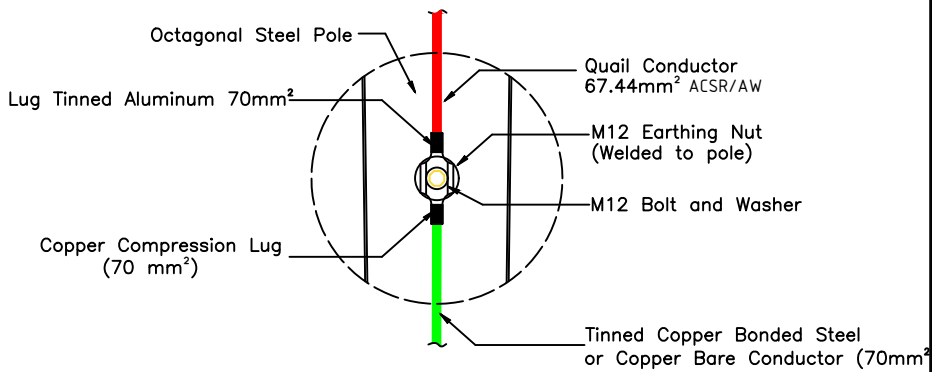


L – 4Nos. 70SQ.MM COPPER TERMINAL LUGS
LA– 1No. LUG TINNED ALUMINUM 70mm²

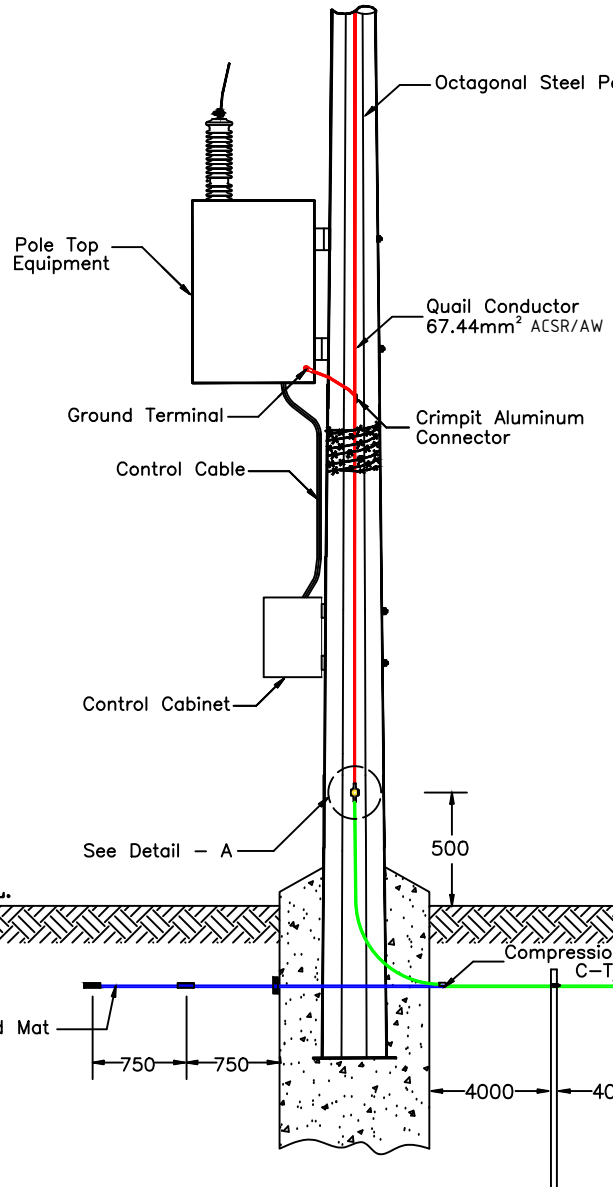
DETAIL–A

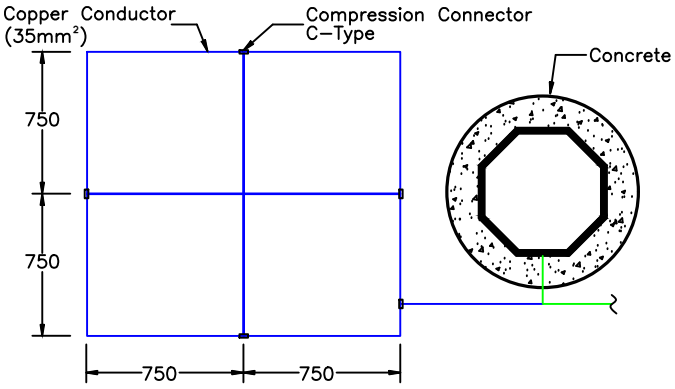
FIG.05 – LIGHTING ARRESTER EARTHING DETAILED DRAWING

ALL DIMENSIONS ARE IN MILLIMETER



DETAIL–A





DETAILS OF GROUND MAT

FIG.06 – BONDING AND GROUNDING ARRANGEMENT FOR POLE MOUNTED EQUIPMENT WITH GROUND LEVEL CONTROL CABINET

ALL DIMENSIONS ARE IN MILLIMETER

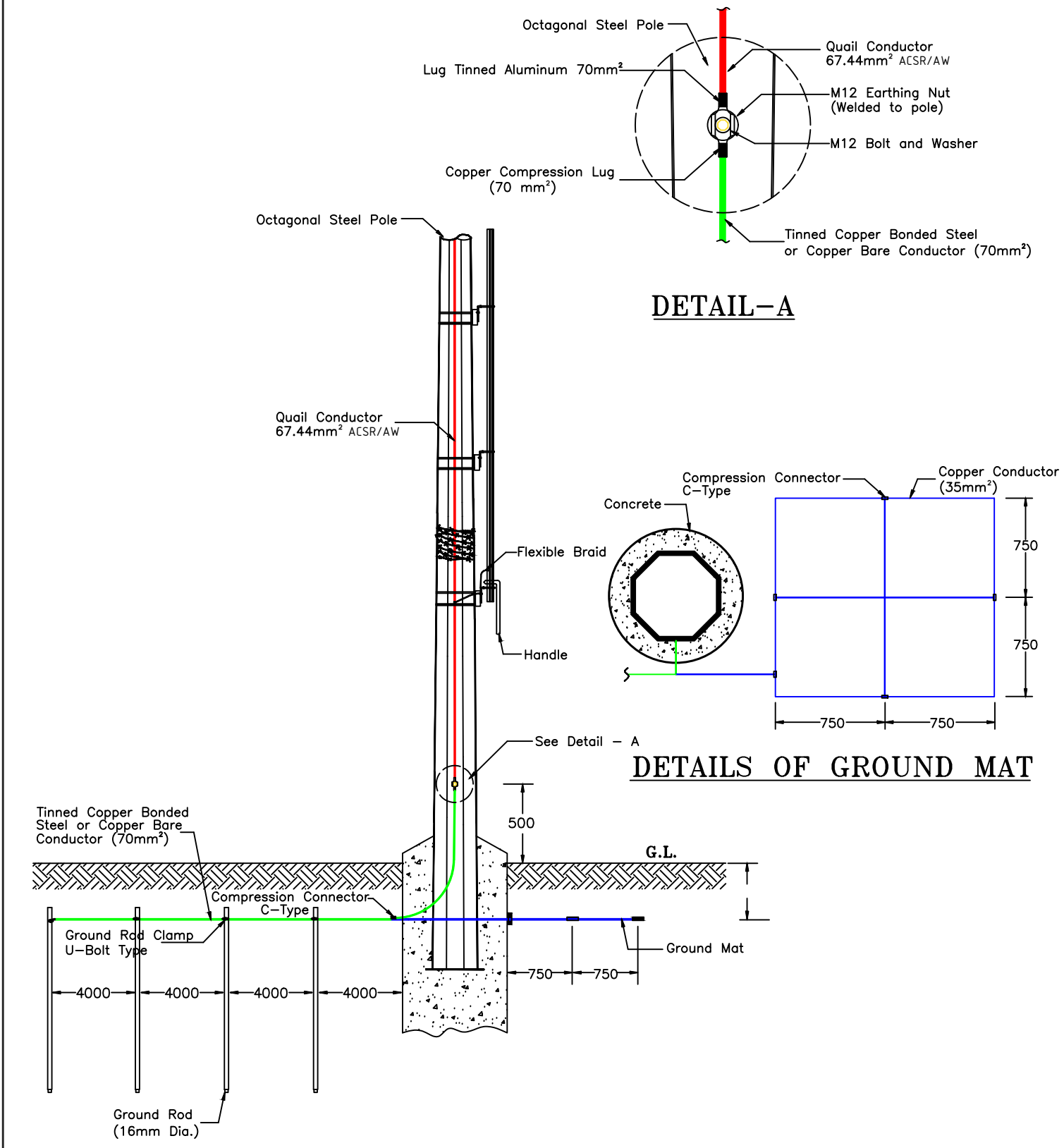


FIG.07 – BONDING AND GROUNDING ARRANGEMENT FOR POLE MOUNTED O/H LOAD BREAK SWITCH WITH GROUND LEVEL OPERATING HANDLE

ALL DIMENSIONS ARE IN MILLIMETER

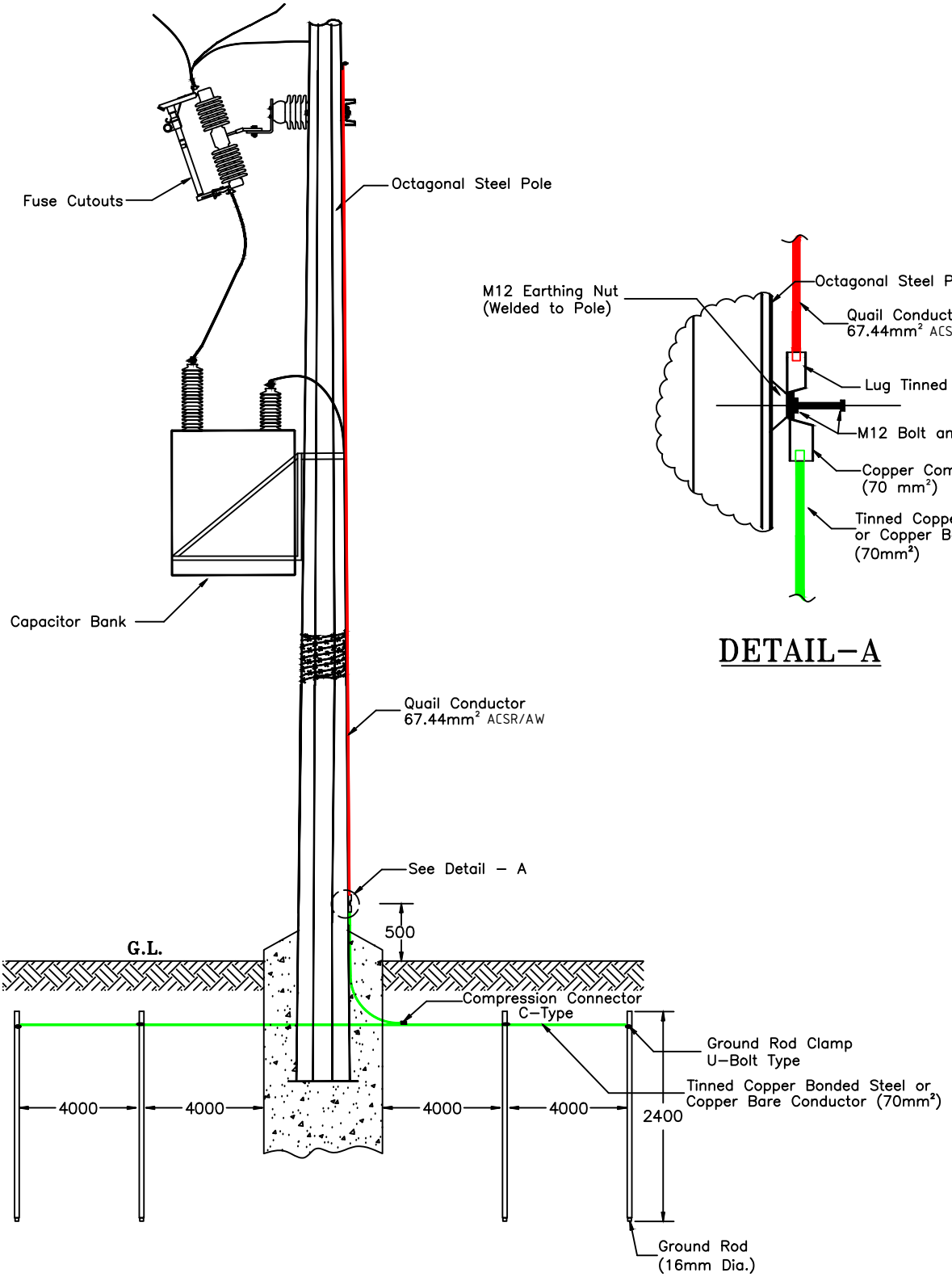
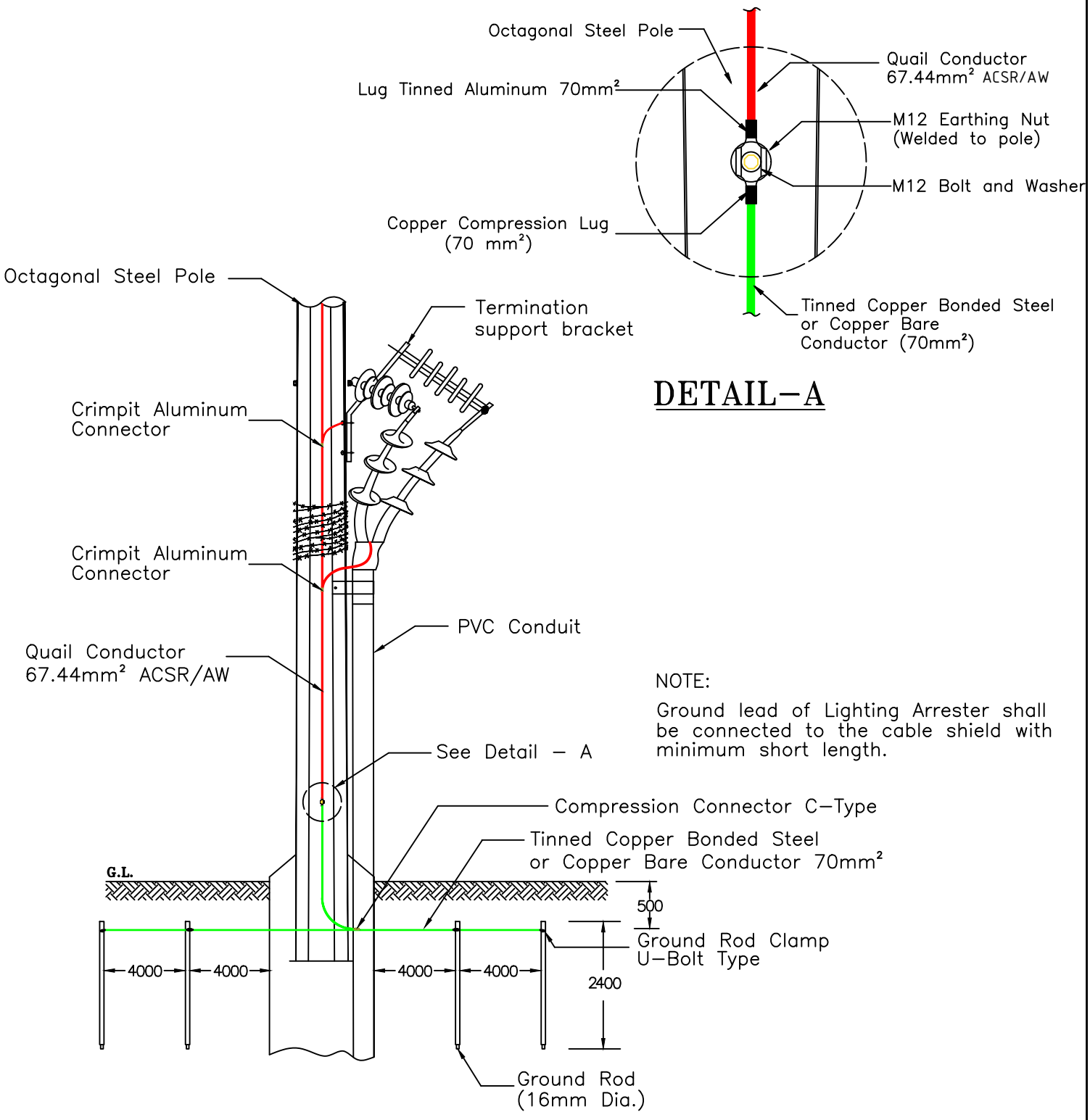


FIG.08 – GROUNDING ARRANGEMENT FOR CAPACITOR BANK (GROUNDED–Y)

ALL DIMENSIONS ARE IN MILLIMETER



NOTE:

Ground lead of Lighting Arrester shall be connected to the cable shield with minimum short length.

FIG.09 – BONDING AND GROUNDING ARRANGEMENT CABLES CONNECTED TO 3–WIRE MV–O/H LINES

ALL DIMENSIONS ARE IN MILLIMETER